insulator reduces the electric field in the material but increases the electric field strength in the air gap and skin.

Furthermore, in applications where the surface is likely to be touched while the electrosensory stimulation or response is given, the effectiveness of the electrosensory stimulus generation can be enhanced by optimal selection of the material that will be touched by the body member. This is particularly significant in connection with insulators which are good volume insulators (insulators in the direction of the surface's normal) but less so in the direction along the surface.

An insulator's insulation capability along the surface may be negatively affected by surface impurities or moisture which have a negative effect on the apparent strength of the sensation felt by the body member to be stimulated. For instance, glass is generally considered a good insulator, but its surface tends to collect a thin sheet of moisture from the air. If the electrode of the CEI is insulated with glass, the electrosensory effect is felt in close proximity (when there is still an air gap between body member and the glass surface). However, when the glass surface is touched, even lightly, the electrosensory tends to weaken or disappear altogether. Coating the outer insulating surface with a material having a low surface conductance remedies such problems. The inventors speculate that if the surface having some surface conductivity is touched, it is the conductive layer on the surface that experiences the coulomb force rather than the body member touching the surface. Instead the touching body member acts as a kind of grounding for the conductive surface layer, for example via the stray capacitance of the body.

Instead of the measures described in connection with FIGS. **10** through **12**, or in addition to such measures, stray capacitances can be controlled by arrangements in which several electrodes are used to generate potential differences among different areas of the touch screen surface. By way of example, this technique can be implemented by arranging the touch-sensitive surface of a hand-held device (eg the top side of the device) to a first potential, while the opposite side is arranged to a second potential, wherein the two different potentials can be the positive and negative poles of the device. Alternatively, a first surface area can be the electric ground (reference potential), while a second surface area is charged to a high potential.

Moreover, within the constraints imposed by the insulator layer(s), it is possible to form minuscule areas of different potentials, such as potentials with opposite signs or widely different magnitudes, wherein the areas are small enough that the user's body member, such as finger, is simultaneously subjected to the electric fields from several areas with different potentials.

FIG. **13** shows an embodiment in which the capacitive coupling is utilized to detect touching or approaching by the user's body member, such as finger. A detected touching or approaching by the user's body member can be passed as an input to a data processing device. In the embodiment shown in FIG. **13**, the voltage source is floating. A floating voltage source can be implemented, via inductive or capacitive coupling and/or with break-before-make switches. A secondary winding of a transformer is an example of a simple yet effective floating voltage source. By measuring the voltage U**4**, it is possible to detect a change in the value(s) of capacitance(s) C**1** and/or C**2**. Assuming that the floating voltage source is a secondary winding of a transformer, the change in capacitance(s) can be detected on the primary side as well, for example as a change in load impedance. Such a change in capacitance(s) serves as an indication of a touching or approaching body member.

In one implementation, the apparatus is arranged to utilize such indication of the touching or approaching body member such that the apparatus uses a first (lower) voltage to detect the touching or approaching by the body member and a second (higher) voltage to provide feedback to the user. For instance, such feedback can indicate any of the following: the outline of the/each touch-sensitive area, a detection of the touching or approaching body member by the apparatus, the significance of (the act to be initiated by) the touch-sensitive area, or any other information processed by the application program and which is potentially useful to the user.

FIG. **14** schematically illustrates an embodiment in which a single electrode and temporal variations in the intensity of the electrosensory stimulus can be used to create illusions of a textured touch screen surface. Reference numeral **1400** denotes a touch-sensitive screen which, for the purposes of describing the present embodiment, comprises three touch-sensitive areas A_1, A_2 and A_3. The approaching or touching by the touch-sensitive areas A_1, A_2 and A_3 of a user's finger **120** is detected by a controller **1406**.

According to an embodiment of the invention, a conventional touch-sensitive screen **1400** can be complemented by an interface device according to the invention. Reference numeral **1404** denotes an electrode which is an implementation of the electrodes described in connection with previously-described embodiments, such as the electrode **106** described in connection with FIGS. **1** and **2**. A supplemental insulator **1402** may be positioned between the touch-sensitive screen **1400** and the inventive electrode **1404**, in case the touch-sensitive screen **1400** itself fails to provide sufficient insulation.

In addition to conventional touch-screen functionality, namely detection of approaching or touching by the touch-sensitive areas by the user's finger, the controller **1406** uses information of the position of the finger **120** to temporally vary the intensity of the electrosensory stimulation invoked by the electrode **1404** on the finger **120**. Although the intensity of the electrosensory stimulation is varied over time, time is not an independent variable in the present embodiment. Instead, timing of the temporal variations is a function of the position of the finger **120** relative to the touch-sensitive areas (here; A_1, A_2 and A_3). Thus it is more accurate to say that the present embodiment is operable to cause variations in the intensity of the electrosensory stimulation invoked by the electrode **1404** on the finger **120**, wherein the variations are based on the position of the finger **120** relative to the touch-sensitive areas.

The bottom side of FIG. **14** illustrates this functionality. The three touch-sensitive area A_1, A_2 and A_3 are demarcated by respective x coordinate pairs $\{x_1, x_2\}$, $\{x_3, x_4\}$ and $\{x_5, x_7\}$. Processing in the y direction is analogous and a detailed description is omitted. The controller **1406** does not sense the presence of the finger, or senses the finger as inactive, as long as the finger is to the left of any of the touch-sensitive areas A_1, A_2 and A_3. In this example the controller **1406** responds by applying a low-intensity signal to the electrode **1404**. As soon as the finger **120** crosses the x coordinate value x_1, the controller **1406** detects the finger over the first touch-sensitive area A_1 and starts to apply a medium-intensity signal to the electrode **1404**. Between the areas A_1 and A_2 (between x coordinates x_2 and x_3), the controller again applies a low-intensity signal to the electrode **1404**. The second touch-sensitive area A_2 is processed similarly to the first touch-sensitive area A_1, but the third touch-sensitive area A_3 is processed somewhat differently. As soon as the controller **1406** detects the finger **120** above or in close proximity to the area A_3, it begins to apply the medium-intensity signal to the